



Enhanced Multi-Objective Optimization of Groundwater Monitoring Networks

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Enhanced Multi-Objective Optimization of Groundwater Monitoring Networks

Tuesday, May 6, 2014: 3:20 p.m.

Blake (Westin Denver Downtown)

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Drinking-water well catchments include many sources for potential contaminations like gas stations or agriculture. Finding optimal positions of monitoring wells for such purposes is challenging because there are various parameters (and their uncertainties) that influence the reliability and optimality of any suggested monitoring location or monitoring network. The goal of this project is to develop and establish a concept to assess, design, and optimize early-warning systems within well catchments. Such optimal monitoring networks need to optimize three competing objectives: (1) a high detection probability, which can be reached by maximizing the “field of vision” of the monitoring network; (2) a long early-warning time such that there is enough time left to install countermeasures after first detection; and (3) the overall operating costs of the monitoring network, which should ideally be reduced to a minimum. The method is based on numerical simulation of flow and transport in heterogeneous porous media coupled with geostatistics and Monte-Carlo, wrapped up within the framework of formal multi-objective optimization. In order to gain insight into the flow and transport physics and statistics that control the optimality of monitoring wells, and thus in order to perform the optimization in a more formal targeted manner, we first use an analytical model based on the 2D steady-state advection-dispersion equation. Monte-Carlo simulation techniques are applied to represent parametric uncertainty. From this, we can obtain maps of contaminant detection probability for all possible placements of one individual monitoring well. Its optimal position is defined by the highest detection probability and describes a limit for meaningful solutions considering additionally early-warning time. Thus, a significant number of potential positions can be excluded from the optimization of entire networks, improving the computational efficiency of network optimization. Finally, we demonstrate that the individual well optima can indeed be found to be part of the results.

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